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THE POMOZDINO EUCRITE

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16. Abstract

The Pomozdino stony meteorite, found in the Koma ASSR of the Russian SFSR in 1964, is discussed, and is shown to be a monomictic breccia eucrite produced by the crystallization of a silicate melt. Mineralogical, chemical and X-ray diffraction analyses were conducted on the meteorite.

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THE POMOZDINO EUCRITE[1]

by

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The Pomozdino stony meteorite was found in 1964, approximately /109* 5 km to the southwest of the city of Pomozdino, Ust'kulom district (rayon) of the Koma ASSR, Russian SFSR by Anatoliy Ulyashev, a 12-year-old student of the Pomozdino middle school, during a student outing on June 15, 1964 (Meteoritnyy byulleten', 1964). I. V. Ignatov, a geography teacher at this school, led the outing. The meteorite lay on the ground in a small crater near the Pyvsyan' yel' stream.

I. V. Ignatov sent the stone Ulyashev had found to the Committee on Meteorites of the USSR Academy of Sciences and in an accompanying letter also reported that in December 1963 at about 5-8 p.m., the students of the school observed a fire-ball that flew in a southwestern direction, which was possibly associated with the meteorite found.

The Pomozdino meteorite is a complete individual specimen with an unusual spotted fusion crust. The brilliant black fusion crust allowed the Pomozdino meteorite to be immediately related to the feldspar achondrites.

The dispersion of the fusion crust in the form of separate sections-islands on the surface of meteorites is rarely observed and is a peculiaritiy of this meteorite, evidently acquired by it

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[1]Report read at the Fourteenth Meteoritics Conference.
* Numbers in the margin indicate pagination in the foreign text.

only during the flight through the terrestrial atmosphere. Remnants of sprays of the dispersed matter that had been blown off the meteorite surface and that partially hardened as globules and striae in sections lost from the fusion crust, attest to this fact (see G. L. Krinov, 1964).

The shape of the Pomozdino meteorite is likewise unusual: it is nearly an ellipsoid of revolution, somewhat flattened at one end. One of its vertices, which is tapered as if drawn out, is somewhat shifted, the other being rounded with indistinctly expressed regmaglypts (Fig. 1a, b). The dimensions of the meteorite are 94 x 52 x 48 mm; it originally weighed 327 g. A rounded vertex and two plates were sawed off from it. One of the plates and part of the other plate were used for thin sections and chemical and granulometric analysis. The loss of meteorite matter in sawing and in preparing the thin sections amounted to about 18 g. The primary mass now weighs 271.6 g. The meteorite, which is dense though 'soft,' was very easily sawed.

The granular texture and light color of the meteorite interior is seen on the surface of the meteorite that lacks a fusion crust. The meteorite in a fresh fracture and on the saw-cut planes is light grayish-yellow in color. A fragmental texture is seen on the saw-cut planes: different angularly shaped fragments, in individual cases reaching 1 cm in diameter,are included in the fine-granular and lighter mass.

In thin sections under a microscope it is evident that the / Pomozdino meteorite consists of coarse-granular sectional fragments, with a sharply expressed diabasic, spotted poikilodiabasic, and, in places, with a doleritic texture of a typical eucrite. The fragment are included in a nonuniform, minute- or fine-granular fragmental mass of the same minerals that make up the fragments of the eucrite

(Fig. 2). Clinopyroxene predominates among the minerals composing this mass as well as the eucritic fragments. The fragments are distributed more or less uniformly by size. They compose, on the average, more than half the mass of the meteorite, varying in different microsections from 49 to 64%.

The fragments of the primary eucrite consist of a light-mauve monoclinic pyroxene, laths, and tables of primary plagioclase, polysynthetically twinned, frequently zonal, and is characterized by an abundance of inclusions and of sections of tridymite. The tridymite sections are distributed nonuniformly, the opaque minerals usually being confined to them. Small needles of apatite (?) and single grains similar to zircon (?) are also observed in the accessory sections.

The variety of shapes and sizes is the characteristic feature of the primary minerals, namely clinopyroxene and plagioclase, that make up the fragments of the original eucrite.

Clinopyroxene amounts to more than half the total mass of the meteorite and of the fragments of the original eucrite. The same quantities are also typical for other eucrites (Lacroix, 1962; Chirvinskiy, Sokolova, 1941, Duke, Silver, 1967; and others). Pyroxene is encountered either in the form of xenomorphic grains reaching 2 mm laterally and sometimes of poikilitic-interpenetrating plagioclases; or in the form of long (up to about 3 mm) spindle- /: shaped grains enveloped with plagioclase as if stuffing them (Fig. 3a); or in the form of an aggregate of fine isometric grains co posing the sections between the laths of plagioclase whose texture may therefore be called doleritic. Finally, pyroxene is observed also in the form of irregular granules in tridymite sections and in the shape of minute inclusions in other minerals. The coarser of its grains usually contain inclusions of opaque minerals measuring 3-15 μ.

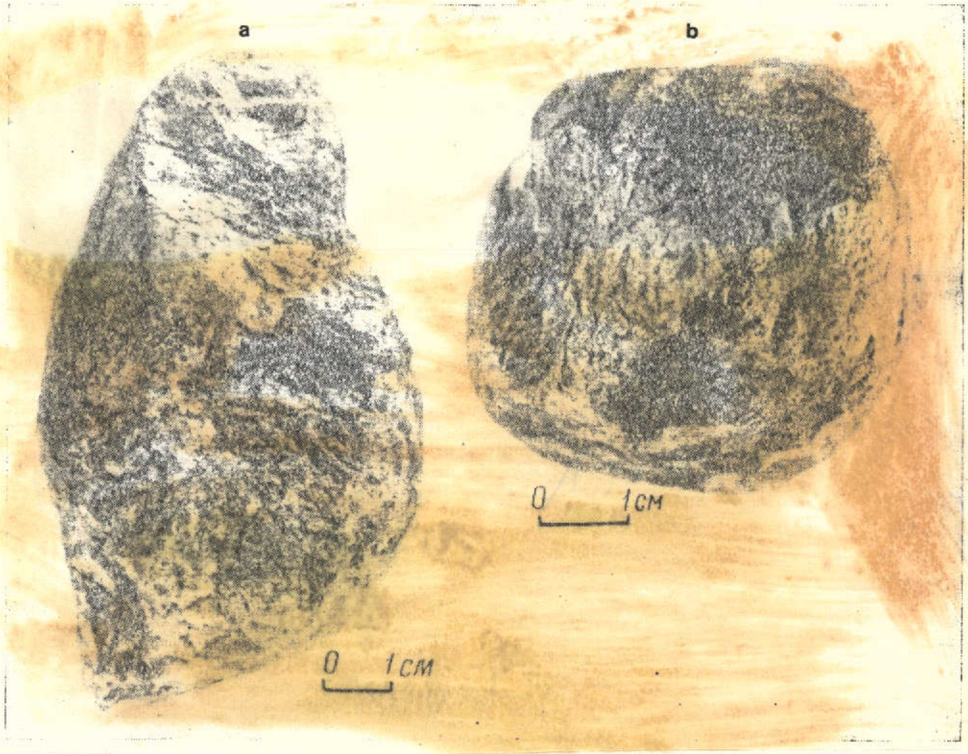

Fig. 1. Exterior view of the Pomozdino meteorite. Photograph by Ye. L. Krinov (1965). a--lateral view; b--view from the rounded rear side with sections covered by the fusion crust (black).

Fig. 2. General view of the microstructure of the Pomozdino meteorite: a fragment of the original eucrite and a fine-framental mass. On the right is a large fragment of a eucrite with poikilo-diabasic textured sections (in the center and at the top of the fragment). Microsection No. 2530. Transmitted light. Without assayer. Magnification 40 X.

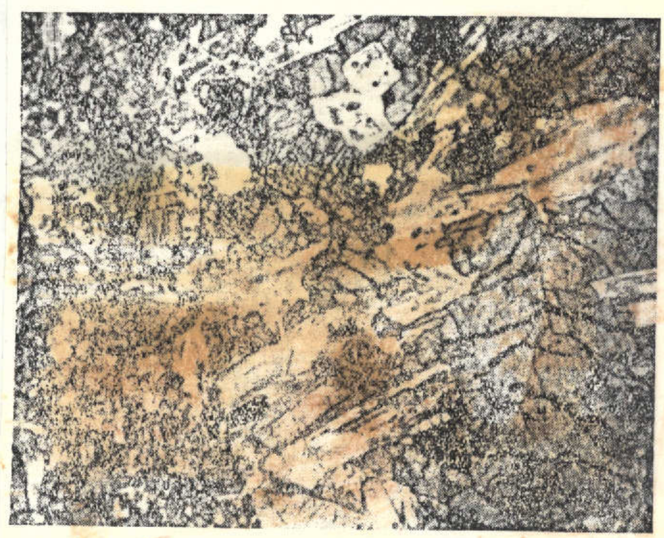

Fig. 3. Details of the microstructure of the Pomozdino eucrite. a--eucritic section with radiated divergent laths of plagioclase, enveloping the spindle-shaped grains of pigeonite with a distinctly expressed cleavage, and minute-granular sections enriched with tridymite (upper right and lower left). Microsection No. 2530. Transmitted light [Without] assayer. Magnification about 40 X: b--central part of (a) magnified about 70 X; abundant microscopic inclusions (dark sections) in plagioclase (white), zonally arranged.

Pyroxene discloses a perfect primatic cleavage and a distinctly expressed rift along (001) (see Fig. 3a, b). Often there are twins along (100) that are usually simple, more rarely polysynthetic. Spottiness in terms of a difference of the extinction angles is noticed in places among the large grains of pyroxene. The pyroxene is characterized by the following crystallographic properties. Under the microscope it is rose-light mauve in color; it reveals a weak pleochroism; according to Ng it is light mauve-rose, according to Nm it is rose-greenish (or brownish), and according to Np it is colorless. The absorbtion diagram is Nm > Ng > Np. The extinction angle Ng : [001] = 32-34°. The positive angle of the optical axes is very small: on the Fedorovskiy stage pyroxene behaves as a uniaxial mineral. On a conoscope it gives the pattern of a positive crystal with angle 2V not greater than 15-20° and with dispersion of the optical axes r greater than v. Its index of refraction Ng $\geq$ 1.734 $\pm$ (the measurement error in immersion liquids was from $\pm$ 0.002 to $\pm$ 0.005), Nm and Np were close and less than 1.720. Birefringence (measured by a Berek compensator) Ng — Np $\approx$ 0.024. These constants allow us to relate the pyroxene (its basic mass) to pigeonite (Dir et al, 1965) approaching the pigeonite of the Moore County eucrite (Hess, Henderson, 1949).

The X-ray diffraction powder pattern obtained (by N. I. Zaslavskaya) for the pyroxene of the Pomozdino meteorite by micromethods proved to be the typical diffraction pattern of pigeonite.

The plagioclases, whose quantity is half the quantity of pyroxene, is observed in the form of laths with length greater than 2 mm, sometimes radially arranged (see Fig. 3), in the form of grains with a cross section the same size, and with irregular contou These grains usually reveal a zonality (with indistinct zonal boundaries) and are filled with microinclusions that are zonally arranged (Fig. 3b). Moreover, abundant small needles of apatite (?) arranged in the form of two oriented, mutually perpendicular systems are observed in separate plagioclase grains.

More minute plagioclases are idiomorphic, particularly of poikilitic intergrowths in the pyroxene.

The extinction angles of the plagioclases in a symmetric zone vary within the limits 30-33°. The plagioclases are polysynthetically twinned, frequently according to the albite law. Plagioclase according to measurements of the twins on a Fedorovskiy stage was shown to be bytownite 82-80 An, and in several cases as labradorite 69-67 An. This difference in compositions is possibly due to the zonality of the plagioclase, as is observed in the plagioclase of the Juvinas eucrite (Game, 1957). In a number of cases, the points determining the composition were closer to the high-temperature curves but not to the low-temperature curves of the plagioclases (Zavaritskiy et al., 1958).

The average index of refraction Nm of most of the grains measured, which proved to be equal to 1.576 $\pm$ 0.004, corresponds to bytownite-An_{80}.

Tridymite in the form of an aggregate of tablets with diameter from 0.7-10 to 30 μ almost entirely makes up the fine sections (see Fig. 3a). Parts in it are sphenoid twins. The extinction angle relative to the twinned seams is 10-18°. Very low birefringence and refraction Nm = 1.472. Tridymite, in places in concretions with veriform grains of pyroxene, seemingly pits the pyroxene in places.

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Single granules, very highly refracting and birefringent, are encountered from the accessory thin sections that are possibly zircon (?).

The opaque minerals are usually confined to the more minute granular sections of the eucrite, which conditions their glomeroblastic arrangement (Fig. 4a). The same glomeroblastic arrangement is kept also in the minute-fragmental sections of the meteorite.

Moreover, opaque minerals are encountered in pyroxene and plagioclase in the form of inclusions, often of rounded shape of from 1-2 and less up to 10-20 μ in diameter.

Fig. 4. Opaque minerals of the Pomozdino eucrite. a--distribution and shape of the opaque minerals (white and very light-gray minute grains) in a fragment of the eucrite. Polished section No. 2530/1. Reflected light. Magnification about 47 X; b--minute-granulated textured particles of native iron. One of them (left) in an accretion with troilite (white). 5 sec. pickling with nital. Magnification about 210 X.

Troilite, oxides, mainly ilmenite, more rarely magnetite and chromite (it is difficult to distinguish one from the other), and native iron were determined among the opaque minerals in a polished section.

Troilite is observed in the form of minute grains that are similar to particles of native iron, being distinguished by a light-yellow color. /114

Ilmenite predominates among the oxides. It is frequently encountered in coarser grains (reaching 0.5 mm in diameter) than are the remaining ore minerals. The grains ususally have an irregular shape, are sometimes isometric, and reveal twins. The color of the mineral is rose-gray. A noticeable pleochroism from rose to light gray in color and cleavability are characteristic.

Magnetite and chromite is observed in the form of granules of from 1-2 to 10-20 μ, and are difficult to distinguish from each other; they are usually observed in the form of inclusions in other minerals.

Native iron is encountered in the form of irregular particles (Fig. 4b) with rounded off, notched contours, of from 0.03 to 0.3 mm in cross section. It easily reduces copper from a $CuCl_2$ solution. Pickling with nital revealed a fine-granular texture for the native iron. As the chemical analysis (see table) has shown, it lacks nickel.

The total quantity of opaque minerals, according to a calculation in a polished section of area 27 X 25 mm, amounts to about 2 vol.-%. Of them, troilite is 0.8; oxides (ilmenite predominates, magnetite and chromite (?) are rarer) are 0.8; and native iron is 0.4. This amounts to about 3.2 and 1%, respectively in scaling by weight-percent.

The quantity of the primary minerals of the Pomozdino eucrite calculated by an ocular micrometer in thin slices with small area was approximately as follows (in wt.-%): in a large fragment of the original eucrite, pigeonite was 65.7; plagioclase and tridymite were 30.1; opaque minerals were 4.2. In the meteorite as a whole, pigeonite was 63.5, plagioclase and tridymite were 31.5; opaque minerals were 5. The fraction of tridymite in a very approximate estimate amounts to about 3 per cent by volume.

The figures obtained for the opaque minerals are obviously high, and we must take 2 vol.-% for them, which is very close to the value also obtained for them by chemical analysis. The results of a chemical analysis performed by M. I. D'yakonova are presented below.

Oxides and elements	wt.-%	Oxides and elements	wt.-%	Oxides and elements	wt.-%
SiO_2	47,97	CaO	10,76	Ni	Not found
TiO_2	0,73	Na_2O	0,41	Co	0,001
Al_2O_3	11,31	K_2O	0,03	(Fe, Ni, Co	0,901)
FeO	14,61	P_2O_5	0,26	Fe	1,77
MnO	0,53	Cr_2O_3	0,10	S	1,02
MgO	9,96	Fe	0,90	(FeS	2,79)
				Total	100,36

[Translator's Note: commas represent decimals]

Fe_{tot} = 14.02; FeO/(FeO + MgO) - 44. Numbers in parentheses were not taken into account in the calculation.

A sample weighing 5.3 g was subjected to analysis. The non-magnetic fraction amounted to (in wt.-%) 97.51, and the magnetic fraction 2.49. The part of the magnetic fraction that was soluble in aqua regia amounts to 1.34 wt.-% (0.0646 g). We determined in it Ni (qualitatively), total Fe (7.10), TiO_2 (0.015%), and S (3.82%), the latter corresponding in content to 10.50% troilite. The other components probably are soluble silicate (?), which we did not determine for lack of material.

The nonsoluble and aqua regia soluble parts of the meteorite sample analyzed amount, on the whole, to 86.81 and 13.19%, respectively. Under analysis a troilite content which is considerable for a eucrite was noted.

The density of the Pomozdino meteorite is equal to 3.10 g/cm^3. /115 The parameters computed according to the data of a chemical analysis (Zavaritskiy, 1950) plotted in the form of vectors on a petrochemical diagram of the feldspar achondrites (Kvasha, 1959) occupy an intermediate position between the vectors of the chemical compositions of the Briyent (D'yakonova, Kharitonova, 1961), Bereba (Lacroix, 1926), and Pasamonte (Foshag, 1938; Duke, Silver, 1967) eucrites, and are very close to the vectors of the Peramiho eucrite (Berwerth, 1903).

The results obtained allow us to conclude that the Pomozdino meteorite is a monomictic "breccia" of eucrite. The fragments of the original eucrite that have been preserved are a nonuniformly granulated, generally coarse-granular eucrite of a bytownite-pigeonite composition containing tridymite. The chemical and mineralogical composition and texture of the fragments of the eucrite characterize it as a product of the crystallization of a silicate melt, which is comparable to the crystallization of a melt close to eutectic in simple systems (Anderson, 1915; Chirvinskiy, 1941).

The compositon of the minerals of the eucrite, particularly the presence of tridymite, indicates that crystallization took place at a high temperature and low pressure, while the inhomogeneity of the structure attests to several stages for this process.

Some deformation of the original eucrite is noticeable, evidently preceding the general fragmentation, which transformed it into a breccia. A similarity is observed in the details of the structure and in the composition of the minerals of the Pomozdino eucrite and the same properties in samples of lunar diabases (Bence et al., 1970; Ramdohr, El Goresy, 1970, and others).

The investigation of the Pomozdino meteorite continues.

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